Original Article

Usefulness of initial diagnostic tests carried out in the emergency department for blunt trauma

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Aim: To evaluate the usefulness of the initial diagnostic tests carried out in blunt trauma patients in our emergency department.

Methods: Blunt trauma patients admitted between October 2009 and October 2011 were retrospectively reviewed. A scoring system was developed (0 to 28 points) to differentiate between potential major trauma patients and physiologically stable patients. Patients were classified into three groups: Group I (minor trauma), revised trauma score normal and our score 0–14; Group II (potential major trauma), revised trauma score normal and our score 15–28; Group III (major trauma), revised trauma score low. The proportions of patients with positive initial diagnostic test results (blood tests, X-rays, and computed tomography) were determined in each group.

Results: The study included 1,291 patients (Group I, 1,019; Group II, 85; Group III, 187). Blood tests and X-rays were carried out frequently in all groups, but positive results were infrequent in Group I. Comparisons using Pearson's χ^2-test showed significant differences in the proportions of patients with positive blood test, X-ray, and computed tomography results among the three groups. The proportions of patients with positive blood test and chest X-ray results were significantly lower in Group II than in Group III, but there were no significant differences in the proportions of patients with other positive results between these two groups.

Conclusions: In physiologically stable blunt trauma patients, diagnostic tests should be selected only after careful patient evaluation. To achieve this, standardized criteria for the identification of minor trauma patients should be established.

Key words: Blood test, blunt trauma, CT, minor trauma, X-ray

INTRODUCTION

DELAY IN THE management of major trauma results in deterioration of the patient's condition and has a negative impact on prognosis. Rapid detection of organ injuries is essential, but comprehensive assessment within a short time period is very difficult. Establishment of a protocol for the initial management of trauma patients is effective and strongly recommended. In our hospital, we routinely use a trauma protocol that we developed in accordance with the Advanced Trauma Life Support guidelines.[1,2]

We previously questioned the usefulness of a standardized protocol for all trauma patients. Trauma patients have injuries with varying degrees of severity, and we consider that a single standardized protocol cannot provide reasonable and effective management for all patients regardless of clinical presentation. Our current initial trauma protocol targets patients with major trauma, and includes a complete physical survey, blood sampling, and imaging tests. We strongly suspect that the majority of trauma patients do not need such extensive investigation, and that this protocol results in excessive use of medical resources.

Several reports have discussed the potential usefulness of developing a separate protocol for evaluation of minor trauma patients.[3–5] However, no previous studies have reported on the usefulness or cost–benefit ratio of the initial diagnostic tests carried out in the emergency department (ED). The aim of this study was to evaluate the frequency and usefulness of the initial diagnostic tests carried out in blunt trauma patients in our ED.

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METHODS

Current procedures for the management of trauma patients in our ED

EMERGENCY MEDICAL COORDINATORS, resident doctors, and paramedical staff are alerted when a trauma patient arrives in the ED. A coordinator directs the

initial trauma protocol. Most patients undergo routine focused abdominal sonography for trauma,[6] blood sampling, and plane X-ray. The results of blood tests and imaging tests are accessed by our computer network. Medical coordinators routinely interpret X-rays, and a radiologist is consulted in difficult cases. Subsequent management is then discussed. The revised trauma score (RTS),[7] injury severity score (ISS),[8] and other patient data are registered in a trauma database.

Grouping of patients

We developed a unique scoring system to identify potential major trauma patients (Table 1). The RTS is currently widely used during field assessments of the severity of trauma. The RTS is easily calculated from the Glasgow Coma Scale score, systolic blood pressure, and respiratory rate. As a deteriorated RTS indicates physiological abnormality, we considered patients with a low RTS at admission to have severe trauma. As we anticipated that there would be few patients with a deteriorated RTS, we considered it necessary to use another scoring system to identify patients with potential major trauma. Because we could not find a scoring system that would be suitable for use in this study, we developed a new scoring system based on our own experience. Our scoring system (0–28 points) included patient background characteristics (age, previous medical history), mechanism of injury, and clinical symptoms. Although our scoring system was newly established and accumulation of data was not sufficient, we decided 14 points as the cut-off score for minor versus potential major trauma in this study. We extracted data for all blunt trauma patients referred to our hospital between October 2009 and October 2011 from the trauma registry. Patients were classified into three groups: Group I (minor trauma), RTS normal and our score 0–14; Group II (potential major trauma), RTS normal and our score 15–28; Group III (major trauma), RTS deteriorated.

Evaluation of the three groups

We collected data regarding the background characteristics and clinical courses of patients by reviewing the electronic medical records. Blood test results (complete blood count, blood chemistry, and blood gas analysis) were considered positive if they were outside the reference range defined by our hospital laboratory. X-ray (X-rays of the head, neck, chest, and pelvis, and computed tomography (CT) of the head, neck, chest, abdomen, and pelvis) were considered positive if abnormalities were observed. The proportions of patients with positive test results in each group were determined.

Table 1. Scoring system for identification of potential major trauma patients

Contents	Score	Contents	Score
Patient's age		Morphology in injured sites	
<75 years	0	Surface of injured site	
≥75 years	2	Major injury (ex. laceration)	2
Injury mechanism		Minor injury (ex. abrasion)	1
Traffic accidents		None	0
Motor vehicle crash (driver or other rider)	1	Deformity of injured site	
Motorcycle crash (driver or other rider)	2	Severe deformity	2
Bicycle crash (driver or other rider)	2	Minor deformity	1
Pedestrian	2	None	0
Fall (>2 m)	2	Strength of persistent pain	
Other low energy mechanisms	0	Intolerable pain	2
Neurological deficits	1	Tolerable pain	1
Episodes of LOC		Slight pain or no pain	0
Episode of vomiting	1	Previous medical history	
Episode of memory disorder	1	Yes	1
Episode of mental confusion (ex. excited)	1	No	0
Motor/sensory disorder	1	History of anticoagulant therapy	
None	0	Yes	2
		No	0

Patients were classified as minor trauma if the revised trauma score was normal and our score was 0–14. Patients were classified as potential major trauma if the revised trauma score was normal and our score was 15–28. ex., excluding; LOC, loss of consciousness.

Statistical analysis

We calculated the 95% confidence intervals (CIs) for the proportions of positive results in each group, and compared the proportions among the groups. Continuous data were compared using the unpaired *t*-test and categorical data were compared using Pearson's χ^2-test. All analyses were carried out using IBM SPSS software, version 21 (SPSS, Chicago, IL, USA). All tests were two-tailed, and significance was set at $P < 0.05$. The study protocol was approved by the ethics committee of Fukushima Medical University (Fukushima, Japan). All data were analyzed anonymously.

RESULTS

A TOTAL OF 1,291 blunt trauma patients were treated at our hospital during the study period, including 1,019 patients categorized as Group I (732 males, 287 females; mean age ± standard deviation [SD], 46.7 ± 16.9 years; mean ISS ± SD, 2.9 ± 1.7), 85 patients categorized as Group II (52 males, 33 females; mean age ± SD, 47.8 ± 14.1 years; mean ISS ± SD, 10.2 ± 4.2), and 187 patients categorized as Group III (111 males, 76 females; mean age ± SD, 44.7 ± 17.7 years; mean ISS ± SD, 19.7 ± 8.6). The mean age was similar among the three groups, but there was a significant difference in mean ISS among the three groups ($P < 0.05$). The mechanisms of injury in Groups I, II, and III were as follows: traffic accidents (640, 68, and 141 cases, respectively), falls from a height of >2 m (268, 14, and 34 cases, respectively), and other (111, 3, and 12 cases, respectively).

The number of tests carried out and the proportions of positive results are shown in Table 2. Blood tests were carried out frequently in all groups. It was difficult to interpret the relevance of the positive results in Group I because the 95% CIs for the proportions of positive results included very low values (range, −0.1 to 1.5). Review of the records indicated that the positive results were not always related to trauma. The 95% CIs ranged from 4.1 to 35.1 in Group II and from 29.5 to 65.5 in Group III.

X-rays were carried out frequently in all groups. It was difficult to interpret the relevance of the positive results in Group I because the 95% CIs for the proportions of positive results included low values. Review of the records indicated that the positive results did not always indicate a need for surgical treatment. The 95% CIs for the proportions of positive X-ray results ranged from −0.1 to 0.8 in Group I, from 4.1 to 33.7 in Group II, and from 8.2 to 52.1 in Group III.

The proportions of patients who underwent CT varied according to the anatomical regions assessed. In Group I, head CT was carried out frequently (481/1091 patients, 47.2%), and the 95% CI for the proportion of positive results was 0.2–2.2; chest CT was carried out in 92 patients (8.4%),

Table 2. Numbers of tests performed, and the numbers and proportions (with 95% confidence intervals [CI]) of positive results

	Group I (*n* = 1019)			Group II (*n* = 85)			Group III (*n* = 187)		
	No. of investigations	No. of positive results (%)	95% CI	No. of investigations	No. of positive results (%)	95% CI	No. of investigations	No. of positive results (%)	95% CI
Blood test									
CBC	986	2 (0.2)	−0.1–0.5	75	10 (13.3)	5.6–21.0	187	78 (41.7)	34.6–48.8
Blood chemical	986	9 (0.9)	0.4–1.5	75	19 (25.3)	15.4–35.1	187	110 (58.8)	51.7–65.5
BGA	939	4 (0.4)	0.0–0.8	68	8 (11.8)	4.1–19.4	187	68 (36.4)	29.5–43.3
Plane X-ray									
Head	872	4 (0.5)	0.2–0.7	75	13 (17.3)	8.7–25.9	174	23 (13.2)	8.2–18.3
Neck	860	2 (0.2)	−0.1–0.6	68	8 (11.8)	4.1–19.4	156	22 (14.1)	8.6–19.6
Chest	980	4 (0.4)	0.0–0.8	75	18 (24.0)	14.3–33.7	187	84 (44.9)	37.8–52.1
Pelvis	866	2 (0.2)	−0.1–0.5	65	15 (23.1)	12.9–33.3	166	28 (16.9)	11.2–22.5
CT									
Head	481	6 (1.2)	0.2–2.2	68	31 (45.6)	33.7–57.3	187	102 (54.5)	47.4–61.7
Neck	12	2 (16.7)	0.3–32.7	20	9 (45.0)	23.2–66.8	48	24 (50.0)	35.9–64.2
Chest	92	12 (13.0)	6.2–19.9	55	27 (49.1)	35.8–62.3	187	116 (62.0)	55.1–69.0
Abdomen	48	2 (4.7)	−1.5–9.8	45	6 (13.3)	3.4–23.2	112	30 (26.8)	18.6–35.0
Pelvis	56	2 (3.6)	−1.3–8.4	22	16 (72.3)	54.1–91.3	112	32 (28.6)	20.2–36.9

BGA, blood gas analysis; CBC, complete blood count; CT, computed tomography.

Table 3. Comparison of proportions of positive results among three groups of major trauma patients

	Group I vs. Group II vs. Group III		Group I vs. Group II		Group I vs. Group III		Group II vs. Group II	
	Pearson's χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value
Blood test								
CBC	409.2	<0.01*	107.5	<0.01*	426.2	<0.01*	31.3	<0.01*
Blood chemical	562.5	<0.01*	161.8	<0.01*	578.3	<0.01*	39.3	<0.01*
BGA	325.1	<0.01*	69.2	<0.01*	340.3	<0.01*	14.4	<0.01*
Plane X-ray								
Head	594.6	<0.01*	111.6	<0.01*	93.9	<0.01*	0.72	0.39
Neck	108.3	<0.01*	103.4	<0.01*	110.1	<0.01*	0.24	0.63
Chest	423.0	<0.01*	216.1	<0.01*	449.8	<0.01*	9.85	0.02*
Pelvis	161.3	<0.01*	176.1	<0.01*	136.6	<0.01*	1.19	0.27
CT								
Head	284.6	<0.01*	186.4	<0.01*	282.2	<0.01*	1.12	0.29
Neck	4.4	0.11	2.7	0.1	16.9	0.10	0.14	0.71
Chest	44.8	<0.01*	22.9	<0.01*	97.7	<0.01*	2.94	0.09
Abdomen	12.4	<0.01*	4.5	0.03*	107.4	0.03*	3.29	0.07
Pelvis	39.7	<0.01*	42.6	<0.01*	14.5	<0.01*	15.6	<0.01*

*Differences were considered significant at $P < 0.05$. BGA, blood gas analysis; CBC, complete blood count; CT, computed tomography.

and the 95% CI was 6.2–19.9. In Group II, head CT was carried out frequently (68/85 patients, 80.0%), and the 95% CI was 33.7–57.3; for pelvic CT, the 95% CI was 54.1–91.3. In Group III, CT was carried out frequently in all areas except the neck, and the 95% CIs for the proportions of positive results ranged from 18.6 to 69.0.

Comparisons of the proportions of positive results are shown in Table 3. Comparisons among the three groups using Pearson's χ^2-test showed significant differences in the proportions of positive blood test, X-ray, and CT results, except for neck CT. Between-group comparisons showed that the proportions of positive results were significantly higher in Group II than in Group I for all tests except neck CT, and the proportions of positive results were significantly higher in Group III than in Group I for all tests. The proportions of positive results were significantly higher in Group III than in Group II for blood tests and chest X-rays, and the proportion of positive results was significantly higher in Group II than in Group III for pelvic CT.

DISCUSSION

DATA FROM THE Japan Trauma Data Bank Report 2012 show that 16.8% of trauma patients had a low ISS score (1–8).[9] The proportion of patients with a low ISS score was different in this study because the majority of patients (1,019/1,291, 78.0%) were categorized as Group I (minor trauma). There are no nationwide data available regarding the proportion of trauma cases classified as minor trauma in Japan, but other provincial cities are likely to have a similar pattern to Fukushima, which provides emergency medical services for 500,000 people. In this study, we used the RTS to identify patients with major trauma based on data from the initial ED assessment. Although use of the RTS alone is imprecise, this simple method allowed us to easily categorize trauma patients. We also developed a scoring system to identify potential major trauma patients. Our scoring system provided a good indication of the severity of trauma, because the proportions of positive results for initial tests were high in Group II. We believe that our scoring system is an effective method of identifying potential major trauma patients.

Blood test results provide important information about the condition of trauma patients. However, we found that most blood tests taken soon after admission to the ED did not provide useful results in Group I patients (RTS normal and our score low). Arterial blood gas sampling was particularly ineffective for obtaining useful information. Keller et al.[10] reported that routine blood tests have little value in the management of injured children. We recommend changing the protocol for initial blood testing in stable patients. In physiologically stable patients, fluid administration results in appropriate hemodilution, and delayed blood testing may therefore provide more useful results.[11]

Stable patients should be carefully examined and interviewed, and selected blood tests should be carried out only if necessary.

X-ray findings are useful for diagnosing organ trauma. Trauma patients traditionally undergo routine X-ray soon after admission.[12] However, X-rays have low sensitivity for detection of blunt trauma injuries, and several reports have questioned the usefulness of routine X-ray in trauma patients.[13–16] In this study, the diagnostic efficacy of X-rays was very low in Group I patients. We recommend that physiologically stable patients should not undergo routine X-ray, and that selected X-rays should be carried out only after careful assessment of the patient.

Computed tomography has very high sensitivity for detection of blunt trauma injuries, and many studies have reported on the diagnostic efficacy of CT.[17–19] Any organ can be assessed by CT, but our results show that the proportion of patients with positive head CT results was very low in Group I. The high frequency of head CT undertaken in trauma patients has been questioned.[20,21] We do not currently have adequate guidelines for carrying out head CT, and many examinations are performed without specific indications. Standard guidelines for carrying out CT in trauma patients should be established.

We acknowledge the importance of the initial tests carried out in the ED in blunt trauma patients. Rapid diagnosis is necessary for survival in cases of severe trauma, and diagnostic test results provide important information. Potential major trauma should not be missed by the omission of diagnostic tests. However, patients with blunt trauma have a wide range of clinical presentations, and routine screening tests may be unnecessary in some patients. Initial tests should be selected according to individual patient assessment to avoid excessive use of medical resources. We believe that it is possible to establish effective and safe guidelines for the use of initial diagnostic tests in blunt trauma patients.

Our study has several limitations. This was a single-center study with retrospective selection and review of patients. Our scoring system for identification of potential major trauma patients was also developed and applied retrospectively. Further prospective studies are needed to establish useful guidelines for the performance of initial diagnostic tests according to trauma severity.

CONCLUSIONS

ROUTINE SCREENING TESTS should not be carried out in patients with minor blunt trauma, because they are unlikely to yield useful information. If ED patients are physiologically stable, the necessary diagnostic tests should be carried out only after appropriate patient assessment. To achieve this, standardized criteria for the identification of minor trauma patients should be established.

CONFLICT OF INTEREST

NONE.

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